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SEEDS GERMINATION OF ORNAMENTAL PALMS HARD TO GERMINATE
1- SEEDS GERMINATION OF *PHOENIX RUPICOLA* T.ANDERSON PALM

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ABSTRACT: *An experiment was conducted at Orman. Botanical Garden, Giza, Egypt under plastic house conditions during 2012 and 2013 seasons to study the effect of some pregermination treatments, including : control (no treatment) , soaking in tap water for either 3 or 6 hours, soaking in previously boiling water for 3 hours and soaking in concentrated sulfuric acid (98.5%) for either 2 or 4 minutes after remove the fleshy exocarp, on seed germination traits and seedling quality of Phoenix rupicola T.Anderson palm .*

The obtained results indicated that most of the used treatments improved germination% and velocity, mean germination rate, germination rate index, vigour index, seed viability and plumule length . Soaking in tap water for 6 hrs. had no significant effect on germination parameters in most cases of both seasons, while seeds soaked in previously boiling water failed to germinate throughout the course of study in the two seasons . Similarly, were those results of vegetative and root growth measurements of the resulted seedlings . The content of chlorophyll a, b, carotenoid, total carbohydrates, total indoles and total phenols was markedly increased as a result of applying the various treatments mentioned above . However, the dominance in all previous parameters was for soaking in concentrated sulfuric acid for 4 min. treatment, as it gave the best means in the two seasons .

So, it could be recommended to soaking Phoenix rupicola T.Anderson seeds after removing the fleshy exocarp in concentrated H_2SO_4 for 4 minutes to obtain high germination rate and seedling quality .

***Key words**: Seed germination,Ornamental palms, Phoenix rupicola T.Anderson palm .*

INTRODUCTION

Phoenix rupicola T.Anderson, Cliff date palm (Fam. Palmaceae) has a solitary trunk up to 8m in height and 20cm in width . It is smaller than the more commonly planted Canary Island and true date palms . It is a tidier tree with a neater appearance as the trunk is clean, not retaining the old leaf bases . As the leaves die they are shed leaving a smooth trunk ringed with narrow scars at the point of allachment . The leaves which grow to about 3.1m long are bright green colour are pinnately arranged in plame on the stem which gives the fronds a flate appearance that conbined with their unique, natural curving, arching and twisting form resulting a very graceful palm. Petiols armed with spines which are less numerous and less vicious than the other phoenix species (Riffle and Craft,2003). It is native to the mountainous forests of India and Bhutan,usually occurring on cliffs, hillsides and similar terrain . It prefers sun but can tolerate shade .It is drought resistant and requires well drained soils, tolerates low temperatures till-3^{o}C. It has a high potential for landscaping use and as a pot plant .

The purplish red fruits are seet but mealy, and are eat by animals and birds . The stem pith is eaten uncooked by lacal Lepcha people (Huxley *et al*., 1992) .

One of the main proplems of ornamental palms planting is the low rate of their seed germination (Broschat and Meerow, 2000). This may be rendered to hard seed coat or endosperm that do not permit the permeability of water, exchange of gases, the expansion of embryo or the outward

diffusion of germination inhibitors (Odetola, 1987) .

Breaking dormaney of hard-coated or endosperm seeds of various plant species was recommended by many investigators . In this regard, Shahin and Arafa (2007) reported that soaking the depulped seeds of both *Butia capitata* and *Hyphaene thebaica* in concentrated sulfuric acid for 6 hrs. significantly improved germination% and velocity, mean germination rate(MGR), germination rate index (GRI), vigour index (VI) and quality of the produced seedlings . This treatment was also reduced thickness and strength of the hard endocarp to the minimum values . Al-Fredan and Ali (2008) mentioned that the highest germination% in doum seeds (93%) was recorded by mechanically scarified seed for 30min. and then soaked in water for 24 hours . The results indicated the need to activate growth of the embryo by soaking the seeds in hot water . Moreover, soaking of Thrinax morrisii seeds in concentrated H_2SO_4 for 30min. resulted in a highest final germination% of 90% in day 14 of culture and number of days lapsed to reach 5% germination of 5.19 days (Dewir *et al*., 2011).

Similar observation were also attained by Myint *et al.* (2010) on oil palm (*Elaeis guinensis*) , Zarchini *et al.* (2011) on *Cycas revolute* and Pivetta *et al.* (2013) on carnauba palm (*Copernicia prunifera*) .

The aim of this study is to secure the most appropriate and reliable treatment to induce the best and fastest germination in cliff date palm seeds with high quality of the produced seedlings .

MATERIALS AND METHODS

This investigation was carried out at Orman Botanical Garden, Giza, Egypt under plastic house conditions (temperature and R.H. ranged beteen 22-36^{o}C and 40-75%, respectively) during the two consecutive seasons of 2012 and 2013 to study the effect of some pregermination treatments on germination charateristics of *Phoenix rupicola* T.Anderson palm seeds .

The fruits were collected at maturity stage and the fleshy exocarp was depulped to obtain the seeds only (photo,1) .

On April 1st for each season, the depulped seeds (the mean weight of 10 seeds was about 10-12 g) were surface sterilized with a 10% sodium hydrochloride solution for 10 minutes, then rinsed several times with sterile distilled water and exposed to the following treatments:

1- No treatment, referred to as control .
2- Soaking in tap water for either 3 or 6 hours .
3- Soaking in previously boiling water for 3 hours .
4- Soaking in concentrated sulfuric acid (98.5%) for either 2 or 4 minutes .

Seeds of the different treatments were sown in 16-cm-diameter plastic pots filled with about 1.5Kg of sand and clay mixture (1:1, by volume) . Some physical and chemical properties are shown in Table (a) .

Photo (1). The depulped seeds of *Phoenix rupicola* ornamental palm.

Table (a): Some physical and chemical properties of the used sand and clay during 2012 and 2013 seasons.

Soile type	Seasons	Particle size distribution (%)				S.P	E.C. (ds/m)	pH	Cations (meq/L)				Anions (meq/L)		
		Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
Sand	2012	89.03	2.05	0.40	8.52	23.01	3.56	7.90	7.50	1.63	33.60	0.50	3.20	22.00	18.03
	2013	84.76	6.29	1.50	7.45	21.87	3.71	7.80	19.42	8.33	7.20	0.75	1.60	7.80	26.30
Clay	2012	10.18	46.17	19.53	24.12	35.00	3.48	8.27	17.50	9.42	20.00	0.79	3.80	10.00	33.91
	2013	10.30	46.54	18.88	24.28	33.07	3.36	7.96	18.00	8.95	20.50	0.85	3.65	10.20	34.45

The pots were arranged in a completely randomized desing (Das and Giri, 1986) with 3 replicates, as each pot containing 7 seeds represents a replicate . Clearly visible plumule protrusion was used as criterion for germination . Irrigation was done day by day throughout the course of study . Data were recorded as follows :

A- Germination characters :

1- Mean length of plumule (cm) after emergence by a week .
2- Germination percentage (G%) from the following equation :
G% = No. of germinated seeds/ total number of sown seeds × 100 .
3- Germination velocity (G.V.), in days : the average number of days from sowing till emergence of the plumule .
4- Mean germination rate (M.G.R.),in days : mean number of days to attain 50% of total germination (Odetola, 1987) .
5- Germination rate index(G.R.I.), which calculated from Bartled equation indicated by Hartmann and Kester (1983):
GRI=A+(A+B)+(A+B+C)...../N(A+B+C+....) .
Where: A,B,C,.....is number germinated seeds counted at different times, and N is number of times at which the germinated seeds were counted .
6- Vigour index(V.I)= G% × Mean length of plumule (Selvaraju and Selvaraj, 1994).
7- Seed viability (S.V.): the number of survived seedlings in each treatment after excluding the deteriorate and dead ones (Odetola,1987) .

B- Seedling characters:

At the end of experiment (after 100 days from sowing), seedling from the different treatments were gently lifted and the following data were recorded: leaf sheath lengths(cm), number of leaves/seedling,root length (cm), number of roots/seedling and fresh and dry weights of the leaves and roots (g) .

C- Chemical determinations :

In fresh leaf samples only taken in the second season(2013) from the various treatments, photosynthetic pigments (chlorophyll a,b and carotenoids, mg/g F.W.) were determined according to the method of Moran (1982), while in the dried leaves samples, the percentages of total carbohydrates (Herbert *et al.*, 1971), total indoles (A.O.A.C.,1980), and total phenols (William *et al.*,1965) were measured .

Data were tabulated and SAS program (1994) was used for statistical analysis, while Duncan's Multiple Range Test (Duncan,1955) was emphyed to test the differences among the means of treatments.

RESULTS AND DISCUSSION

1. Effect of pregermination treatments on : germination and seedling characters :

1.1- Germination characters:

Data in Table (1) show that germination% reached only 100% in the two seasons when the seeds were chemically scarified with concentrated sulfuric acid for either 2 or 4 min. compared to 58.33 and 54.76% for control in the first and second seasons, respectively . Soaking in tap water for 3 hrs. increased such trait to 80% in both seasons, whilst soaking for 6 hrs. decreased it 40.33% in the firest season and to 38.12% in the second one. Seeds soaked in previously boiling water failed to germinate giving 0.0% in the two seasons . This may be attributed to the harmful effect of boiled water on vitality of embryo . However, Zarchini *et al.* (2011) found that highest acceleration of *Cycas revoluta* seed germination was recorded in seeds pretreated with hot water at 80°C for 12 hrs. The most germination rate and value were obtained in seeds pretreated with hot water at 100°C for 1 hrs. along with 25% sulfuric acid for 2 hrs.

The least number of days lapsed to reach either the final or 50% of germination was recorded by soaking in concentrated H_2SO_4 treatment, except for G.V.trait which was the least in the 1st season by control treatments. It was also noticed that the means of GRI,VI and SVwere significantly increased by the different treatments used in this work compared the values of control in most instances of both seasons with the superiority of soaking in concentrated H_2SO_4 treatment for 4 min., which gave the highest means in the two seasons . Asimilar trend was also obtained regarding plumule length (cm) of the germinated seeds under various treatments in both seasons .

Table (1): Effect of some pregermination treatments on some germination traits and plumule length of *Phoenix rupicola* T. Anderson palm seeds during 2012 and 2013 seasons.

Pregermination treatments	Germination (%)	Germination velocity (days)	MGR (day)	GRI	Vigour index	Seed viability	Plumule length (cm)
	First season: 2012						
Control	58.33c	60.41c	78.50a	0.51c	77.58c	5.00c	1.33d
Soaking in tap water for 3hrs.	80.00b	76.50ab	74.40b	0.57b	118.40b	8.00b	1.48c
Soaking in tap water for 6hrs.	40.33d	81.00a	0.00	0.63ab	58.88d	4.00c	1.46c
Soaking in boiled water for 3hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soaking in H_2SO_4 (concn.) for 2hrs.	100.00a	62.90c	59.36c	0.58b	189.00ab	10.00a	1.89b
Soaking in H_2SO_4 (concn.) for 4hrs.	100.00a	67.56b	55.10d	0.67a	221.00a	10.00a	2.21a
	Second season: 2013						
Control	54.76c	56.80cd	79.76a	0.48d	68.45d	4.60c	1.25d
Soaking in tap water for 3hrs.	80.00b	72.18b	75.00b	0.54cd	111.20c	7.44b	1.39c
Soaking in tap water for 6hrs.	38.12d	76.25a	0.00	0.59b	51.46e	4.00c	1.35c
Soaking in boiled water for 3hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soaking in H_2SO_4 (concn.) for 2hrs.	100.00a	58.30c	60.33c	0.58c	176.00b	9.33a	1.76b
Soaking in H_2SO_4 (concn.) for 4hrs.	100.00a	54.78d	52.64d	0.70a	218.00a	10.00a	2.18a

- MGR: Mean germination rate and GRI: Germination rate index.
- Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.

It seems from the aforestated results that concentrated sulfuric acid improved the most germination traits because of its ability on softening the very hard endosperm of phoenix seeds which consequently permits the ease permeable of water and gasses across this soften endosperm, and this of course leads to activating the enzymes which decay the complex nutritional substances of the endosperm to produce the required energy for growth of the embryo (McDonald and Kwong, 2005) . These results are in agreement with those revealed by Shahin and Arafa (2007) on *Butia capitata* and *Hyphaene thebica*, Al-fredan and Ali (2008) on *Hyphaene thebica,* Dewir *et al.* (2011) on *Thrinax morrisii* and Pivetta *et al.* (2013) on *Copernicia prunifera* (carnauba palm).

Contrary to our observations, da Luz *et al.* (2008) noted that germination% and emergence speed index of lady palm (*Rhapis excelsa*) seeds were not affected by mechanical scarification (with sandpaper in one or both sides of the seed), thermal scarification (immersinon in 100^{0}C water over 1,2 or 4 min) and chemical scarification (immersinon in 98% sulfuric acid during 1,2 and 4 min.) .

1.2- Seedling growth characters :

As shown in Tables (2) and (3) , it is clear that most pre- germination treatments used in such trial improved most growth parameters means of the produced seedlings (expressed as : leaf length(cm), leaf sheath length(cm),No. leaves/seedling, root length(cm), No.roots/seedling as well as fresh and dry weights(g) of leaves and roots) with various significance levels when compared to the means of control in both seasons . Soaking in tap water for 3 hrs. treatment gave better results than soaking for 6 hrs. one, as the latter regisrtered values closely near to those of control with non-significant differnces among them in most cases of the two seasons .The opposite was the right concerning soaking in concentrated H_2SO_4 , where elongating soaking time to 4 min. recorded better results than soaking for 2 min. Therefore, the mastrey in all previous growth characters in the two seasons was for soaking in concentrated H_2SO_4 for 4 min. treatment which gave the utmost high averages over all other treatments (Photo,2).

Improvement vegetative and root growth of seedling due to soaking in sulfuric acid may be ascribed to that this treatment accelerates seed germination, and consequently provides the seedling with more time necessary for more growth . Moreover, sulfuric acid softs the hard endosperm of seeds and hence, increasing their ability to absorb more water necessary for hydrolysis of the complex food reserves to absorbable forms (McDonald and Kwong, 2005) . On the same line, were those findings postulated by Shahin and Arafa (2007) on butia and doum, and Al-Fredan and Ali (2008) on doum .

Photo (2). Seedling of control compared to that of the best treatment.

Table (2): Effect of some pregermination treatments on some growth traits of *Phoenix rupicola* T. Anderson seedlings during 2012 and 2013 seasons.

Pregermination treatments	Leaf length (cm)		Leaf sheath length (cm)		No. leaves/seedling		Root length (cm)		No. roots/seedling	
	2012	2013	2012	2013	2012	2012	2013	2012	2013	2012
Control	15.5c	17.3c	3.7c	4.1b	1.0b	1.0b	14.0c	15.3c	4.0c	4.4c
Soaking in tap water for 3hrs.	23.7b	24.5b	4.0b	4.5ba	1.0b	1.0b	16.5b	18.0b	4.0c	4.9bc
Soaking in tap water for 6hrs.	17.0c	18.5c	3.8c	4.1b	1.0b	1.0b	13.4c	15.5c	3.0d	4.3c
Soaking in boiled water for 3hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soaking in H_2SO_4 (concn.) for 2hrs.	24.2b	26.4b	4.1b	4.5ba	1.33b	1.0b	17.1b	18.7b	5.5b	5.5b
Soaking in H_2SO_4 (concn.) for 4hrs.	29.0a	30.8a	4.6a	4.8a	2.0a	2.0a	17.9a	20.0a	8.0a	7.5a

- Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.

Table (3): Effect of some pregermination treatments on leaves and roots fresh and dry weights of *Phoenix rupicola* T. Anderson seedlings during 2012 and 2013 seasons.

Pregermination treatments	Fresh weight (g)				Dry weight (g)			
	Leaves		Roots		Leaves		Roots	
	2012	2013	2012	2013	2012	2013	2012	2013
Control	0.32c	0.35c	0.16b	0.18c	0.16c	0.18c	0.10bc	0.11c
Soaking in tap water for 3hrs.	0.65b	0.63b	0.20b	0.23b	0.33b	0.32b	0.12b	0.14b
Soaking in tap water for 6hrs.	0.34c	0.35c	0.16b	0.17c	0.17c	0.18c	0.09c	0.10c
Soaking in boiled water for 3hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soaking in H_2SO_4 (concn.) for 2hrs.	0.69b	0.71b	0.21b	0.24b	0.35ba	0.34ba	0.13b	0.15b
Soaking in H_2SO_4 (concn.) for 4hrs.	0.84a	0.82a	0.30a	0.33a	0.43a	0.40a	0.18a	0.20a

- Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.

2. Chemical composition of the leaves :

According to data presented in Table (4), it can be concluded that all pregermination treatments applied in this study markedly improved chlorophyll a,b and carotenoids (mg/g F.W.), as well as the percentages of total carbohydrates, total indoles and total phenols as compared to the contents scored by control treatment, with prevalence of soaking in concentrated sulfuric acid treatment for 4 min. that gave the highest content at all . The rate of increasing in chlorophylls a and b was more pronounced then in carotenoids . So, increasing rate of total carbohydrates took asimilar trend . In addition, increasing rate total indoles content ranged between 82.4-152.9% to be higher than that of total phenols one, which ranged only between 16.7-100% . This may be a reasonable reason for enhancing growth of the produced seedling by acid scarification treatment more than other ones.

Table (4): Effect of some pregermination treatments on some constituents in the leaves of *Phoenix rupicola* T. Anderson during 2013 season.

Pregermination treatments	Chlorophyll a (mg/g F.W.)	Chlorophyll b (mg/g F.W.)	Carotenoids (mg/g F.W.)	Total carbohydrates (%)	Total indoles (%)	Total phenols (%)
Control	0.913	0.401	0.395	14.504	0.017	0.018
Soaking in tap water for 3hrs.	1.522	0.805	0.406	20.656	0.042	0.030
Soaking in tap water for 6hrs.	0.938	0.438	0.400	15.337	0.031	0.021
Soaking in boiled water for 3hrs.	0.000	0.000	0.000	0.000	0.000	0.000
Soaking in H_2SO_4 (concn.) for 2hrs.	1.501	0.796	0.401	20.700	0.041	0.030
Soaking in H_2SO_4 (concn.) for 4hrs.	1.536	0.817	0.420	21.793	0.043	0.036

These results may be interpreted according to the inhibitory effect of phenols as indicated by Kenneth (1979) who revealed that phenolic compounds have been known to modify the activity of IAA-oxidase and might therefore be acting on plant activities by way of changes endogenous auxins activity . Analogous gains were also elicited by Shahin and Arafa(2007) on butia and doum, Myint *et al.* (2010) on oil palm and Zarchini *et al.*(2011) on *Cycas revoluta* .

From the foregoing, it is concluded that soaking *Phoenix rupicola* seeds in concentrated sulfuric acid for 4 min. may be the best way for the best germination and seedling quality .

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إنبات بذور بعض أنواع نخيل الزينة صعبة الإنبات

1- إنبات بذور نخيل الفوانكس روبيكولا .

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الملخص العربى

أجريت تجربة بحديقة الأورمان, ، الجيزة ، مصر , تحت ظروف الصوبة البلاستيكية خلال موسمى 2012 ، 2013 وذلك لدراسة تأثير بعض معاملات ما قبل الإنبات ، والتى إشتملت على : المقارنة (بدون معاملة) ، النقع فى ماء الصنبور لمدة 3 أو 6 ساعات ، النقع فى ماء سبق غليه لمدة 3 ساعات , والنقع فى حمض كبريتك مركز (98.5 %) لمدة 2 أو 4 دقائق بعد إزالة الغلاف اللحمى الخارجى على صفات الإنبات وجودة الشتلات الناتجة من زراعة بذور نخيل الفوانكس روبيكولا (*Phoenix rupicola* T.Anderson).

ولقد أوضحت النتائج المتحصل عليها أن معظم المعاملات المستخدمة بهذه الدراسة حسنت نسبة وسرعة الإنبات ، متوسط معدل الإنبات (عدد الأيام حتى 50% إنبات)، معامل سرعة الإنبات ، دليل قوة الإنبات ومتوسط طول الريشة. لم يكن لمعاملة النقع فى الماء لمدة 6 ساعات تأثيراً معنوياً على صفات الإنبات فى معظم الحالات بكلا الموسمين ، بينما فشلت البذور التى نقعت فى ماء سبق غليه فى الإنبات خلال مدة الدراسة فى كلا الموسمين . بالمثل ، كان إتجاه نتائج قياسات النمو الخضرى والجذرى للشتلات الناتجة . ولقد تحسن بشكل ملحوظ محتوى الأوراق من كلوروفيللى أ ، ب والكاروتينويدات ومن الكربوهيدرات الكلية ، الإندولات الكلية والفينولات الكلية نتيجة لإستخدام المعاملات سالفة الذكر .

إلا أن السيادة فى جميع القياسات السابقة كانت لمعاملة النقع فى حمض الكبريتك المركز لمدة (4 ق) والتى أعطت أفضل المتوسطات على الإطلاق بكلا الموسمين .

وعليه ، يمكن التوصية بنقع بذور نخيل الفوانكس روبيكولا بعد إزالة الغلاف اللحمى الخارجى فى حمض الكبريتك المركز لمدة (4 ق) للحصول على أفضل وأسرع إنبات وأعلى جودة للشتلات الناتجة .